APPENDIX H.

DETAILED SYLLABUS.

(AS APPROVED BY THE BOARD OF STUDIES IN ENGINEERING AND THE UNIVERSITY COUNCIL FOR THE MODIFIED COURSES OF STUDY IN ENGINEERING.

First Examination in Engineering.

MATHEMATICS.

Algebra.—Exponential and logarithmic series. Elementary summation of series. Theory of Equations: Relation between roots and coefficients; Transformation of equations; Binomial and reciprocal equations; Location of roots: Numerical solution (Horner's Method); Solution by Graphs.

Trigonometry.—Circular and Hyperbolic functions and their expansions. Spherical triangles and their elementary properties.

Mensuration.—Plane and Solid.

Analytical Geometry.—The Circle, the Parabola, the Ellipse, and the Hyperbola referred to rectangular axes. Polar Co-ordinates. Position of a point in space. Direction cosines. Equations of a plane, straight line, cylinder and sphere.

Elements of Differential and Integral Calculus.—Limits. Rules for differentiation. Standard forms. Derivative as a rate measurer. Geometrical and Mechanical applications. Maxima and Minima. Integration: Standard forms. Definite integrals. Integral as an area. Volumes of revolution (simple cases).

ENGINEERING PHYSICS.

A brief revision of the portions of Physics taught in the I.Sc., course leeding to Engineering, with a more advanced treatment of certain parts with reference to practical applications.

Heat.—Calorimetry with Radiation corrections. Specific heat of gases at constant pressure and constant volume. Critical temperature. Vapour pressure and its variation. Hygrometry. Determination of J. Adiabatics and Isothermals.

Light.—Photometry; theory and practice of photography; determination of the characteristics of photographic materials, colour sensitivity and use of light filters.

Acustics.—General laws relating to production and velocity of sound; pitch, intensity and quality of a note; interference; echo, resonance, reverboration and absorption due to distance, physical property and configuration and size of engineering structures and their parts.

Electricity, Static and Dynamic.—Charge, Potential and Capacity of Condensers Discharge Current; Quadrant Electrometer. Specific Inductive Capacity. Comparison of Capacities. Dry Cells, Secondary Batteries and behaviour in charging and discharging. Electromagnetic Induction, Oversted's experiments. Self Induction. Induction Coil. Elementary description of D. C. and A. C. Dynamos and Motors. Description of Electric measuring intruments including Wattmeters.

Magnetism.—Magnetic properties of Iron and Steel. Permeability. Hysteresis, Definition of Gauss, Maxwell and Gillbert of Magnetic Flux, Magnetic field; methods of making magnets; The earth's magnetic field, direction and intensity.

Practical Course to include Testing of spirit levels, Young's Modulus of wires, Young's Modulus by extension and bending, Modulus of Rigidity, Moments of Inertia, Kater's Rigid Pendulu, Pyrometric Measurement, Thermal Conductivity, Mechanical Equivalent of Heat, Photometry, Intensity of Illumination, Magnetic Field Study, Ice pail Test, Equivalent of Heat Instruments, Wheatstone's Bridge, Potentiometer, Kelvin's Balance, Heating effects of currents, Electrolytic Current Measurements, Electromagnetic Induction and the simple Galvanometers.

ENGINEERING CHEMISTY.

(1) *Metals. e.g.*, Iron, Copper and its alloys, Sodium, Calcium, Magnesium, Aluminium, Zinc, Tin, Lead, Chromium, Nickel, Tungsten, Manganese, Antimony and Mercury and their important compounds, properties and uses.

(2) *Water.*—Composition, Sources, Impurities, Gaseous, Mineral, Organic, suspended, etc. Solvent power of Water; Temporary and permanent hardness. Production of scale, corrosion, foaming, etc. Treatment of Waters. Water softening; Boiler Compounds. Analysis of waters, use of Lead pipes, Chemicals, etc., used for softening.

(3) *Fuels.*—Chemical composition and analysis of solid fuels, *e.g.*, Wood, Charcoal, Coke and Coals; Liquid fuels like Kerosene, Paraffin, Petrol, Crude Oil, and Gaseous fuels like Producer Gas, Coal Gas, Oil Gas, and Blast Furnace Gas. Sampling and Chemical analysis of fuels and fuel gases.

(4) *Refractory Materials*—Acid, Basic and Neutral; General conditions of their service; Applications to Furnace and other practices; Fireclays and Fire Bricks.

(5) *Brick and Other Clays.*—Composition, Varieties and Properties. Drying and Fusibility. Clays. Defects in Clay and their removal; Brickmaking and Tile making; Colors of Tiles; Stoneware Pipe making.

(6) *Plasters and Limes.*—Plaster of Paris, Cement Plaster, Flooring Plaster; Hard-finish Plaster, Slaking of Line. Non-Hydraulic Limes; Testing of Limes; Theories of Setting of Mortars, Plasters and Hydraulic Materials.

(7) *Portland Cement.*—Natural Cement; Composition of Portland Cement. Chemical Analysis of Cements and action of Destructive Agents, Acids, Salt water, etc. on Concrete. Reinforced and plain Cement works.

(8) *Paints and Varnishes.*—General Characters, Composition of Pigments; Paint and Varnishing Oils and fats and their examination. Fillers, Thinners, Driers; Solvents. Composite Paints. Paints for Metals. Paints for wood and other works. Anticorrosive Paints. Varnishes, Resins, Japanning and Lacquer work. Enamelling, Tin plating and Galvanising.

(9) *Lubricants.*—General requirements; Vegetable, Animal and Mineral Oils and Fats; Greases and Chemical Tests on Lubricants; Corrosion on Steel, Brass, Cast Iron, etc.

(10) *Grinding Materials.*—Carborundum, Emery and other Stones used; Composite hardness and general character and properties.

(11) *Electro-Chemistry*—Theory of electrolysis and of the principal electrolytic processes. Chemistry of primary and secondary batteries. Use of electric currents for heating and for chemical decomposition.

Practical Chemistry.—Course to include:—

Gravimetric analysis of iron, copper, zinc, calcium, magnesium, silica, carbon dioxide.

Volumetric analysis: acidimetry and alkalimetry. Calcium determination, Chlorine in water. Determination of Hardness.

Chemical Testing of Iron.—Fire testing of qualities of clay. Brick-earths and Stones. Determination of Ash, Coke, Sulphur, etc., in Solid, Liquid, and Gaseous fuels. Furnace temperature determination.

Analysis of Oils, Lubricants and Paints.

ECONOMICS.

(An elementary course in the Principles of Economics to correlate the same with Problems of Engineering.)

Principles af Economics and outlines of Economic theory with reference to their applications in modern business, trade, commerce, and industry.

The ideas of political economy and the methods by which they are studied; relation of economic science to practice; the meaning of economic law; demand and consumption: the law of diminishing utility; the factors in production and their combination; labour and natural agents; increasing and decreasing returns; capital, its influence, and the conditions of its accumulation. Value in relation to riches, price and utility, and cost of production; determinants of ratios of exchange; the elements of cost; complex problems of value; the theory of international trade and its relation to the home trade; the law of rent, interests and profits; causes of the rates of wages. General theory of the value of money; the value of foreign bills; principles of taxation.

BUILDING MATERIALS AND CONSTRUCTION.

Stones.—Structure, Classification and characteristic qualities of Indian and European Building Stones; Artificial Stones; Quarrying and Blasting; Preparation and use; Dressing Stone, Implements.

Bricks and Tiles.—Brick and Tile Earths; Preparation of Bricks and Tiles by ordinary methods and by use of Machinery; Burning in Clamps and Kilns; Hoffman's Kiln; Improved Types of Kilns; Characteristics of good Bricks; Earthen and Stone-ware products, Terra Cotta, etc.

Limes, Cements, Sand, Surki, Mortars—Source of supply, properties, preparation and use, Ordinary and Hydraulic Mortars, Portland Cement its manufacture and use. Practical tests of limes and cements; Concrete (plain and reinforced); Plastering, Pointing and Whitewash, Bitumen, Gypsum and Plaster of Paris.

Timber.—Growth and felling; Seasoning, natural and artificial; conversion and preservation of timber; Defects in timber; destructive agents and decay of timber. Characteristics of good timber; Principal use, Important varieties in use in India; Woods suitable for special purposes.

Preservation and Preservative Coating of Materials.—Distemper, Oil paint, Colour ash, Paints, Varnishes and Miscellaneous materials as Papering, Putty, Glazing, etc. mposition, preparation and use.

Metals.—Cast Iron, Wrought Iron and Steel. Elementary description of processes of manufacture; Malleable castings. Steel, its properties including hardening and tempering etc. Varieties and uses. Use of other metals: copper, zinc, lead and the common alloys. Definition and explanation of Engineering terms used in Metallurgy.

Elementary Building Construction.—Composition, mixing and laying of Concrete; Good and bad foundations; Depth and width on varying soils; Bond in Brick and Stone Masonry; Simple Joints in Carpentry and Joinery. Definition of terms used in a building :— Foundation, Plinth, Basement, Floor, Superstructure, Parapet Wall, Arches, Piers, Pillars, Pilasters, Balustrade.

Principal structural details of sloping and flat roofs for simple buildings.

WORKSHOP THEORY.

Workshop Theory.—Lectures on the Construction and use of Tools.

(*i*) *Carpentry Shop.*—Carpentry tools.—making, use and care in handling, sawing, chipping. and planing; Selection of tools with reference to kind of wood: Grinding and tempering of tools: Principles of Joinery: Simple Joints.

(ii) *Fitter's Shop.*—Fitter's Tools :—Cold chisels and hot chisels of various cutting edges, the tool angles, shapes, cutting angles, etc. Making of chisels, Tempering of chisels and handling of chisels. Hammers in hand fitting; how made, how fixed to handles, material and composition. Files of different shapes and sizes: how made and tempered. Handling of files. Use of the straight edge scrapers: making and use: Surface plate testing: scraping of plain and curved surface. Scribing block-surface gauge, etc.

Tapping and Screwing.—Whitworth's sets and others, their details. How to use them on steel, cast iron, brass, etc.

Fitting Appurtenances like spanners, chain or pipe wrenches, pipe vices, clamps, etc. Screw jacks, etc., and vices.

(iii) *Foundry.*—Timbers used in pattern making. Pattern maker's tools. Rectangular and circular patterns. Loam Patterns. Plaster and Metal Patterns. Patterns for pulleys, toothed wheels, worm gears screws, etc. Makeshifts. Pattern shop machinery and their maintenance.

Materials used in moulding. Foundry tools. Dry sand, green sand and loam moulding. Methods of moulding, open sand, bedding in and turning over methods. Details of moulding. Cores and core boxes. Cupola and its working. Hard and soft mixtures. Defects in castings. Machine moulding.

(iv) *Smithy.*—General arrangement of a smithy. Stock fire and open fire. The blast. Centrifugal blowers and Root's blowers. Smith's tools. Operations in Smithing. Welding. Forms of welded joints and their relative strengths. Forging, stamping and drop forging. Use of steam and pneumatic hammers.

ELEMENTARY MECHANICAL ENGINEERING AND METALLURGY.

Metallurgy.—Outlines of the main Metallurgical processes of the following metals, their chief uses and tests :—Copper, silver, aluminium, lead, tin, antimony, iron, chromium and manganese.

Simple Metallurgical Process.—Solid solutions, hardening, annealing, tempering, alloys, brasses, bronzes and welding of metals.

Pig Iron.—Its manufacture from ores, composition and uses. Details of Blast furnace and management.

Cast Iron.—Composition of several kinds of cast iron and their strength in compression, tension, etc. Impurities in cast iron and their effect on sound casting and strength.

Mild Steel.—Manufacture by Bessemer and open hearth processes. Influence of cast iron and other metals on the properties of the metal. Simple tests for finding the quality of steel. Tempering and annealing process.

Wrought Iron.—Its manufacture, properties and uses.

Other Metals.—Strength and properties of copper, lead, brass and their alloys. Preservation of Metals.

Machine Details.—Rivets and riveted joints, keys, nuts and locking devices for nuts. Pipes and pipe joints, shafts and simple couplings, simple types of bearings, hangers and wall-brackets.

PRACTICAL SOLID GEOMETRY AND GEOMETRICAL DRAWING.

(*a*) *Practical Plane Geometry.*—Problems on lines, triangles, quadrilaterals, circles and polygons. Inscribed and circumscribed figures, proportional lines and angles, areas of plane figures, construction and use of scales.

(*b*) *Curve Tracing.*—Parabola, Ellipse, Hyperbola, Cycloid, Spiral and other common curves and their chief properties.

(*c*) *Practical Solid Geometry.*—Projections of points, lines and planes, projection of simple solids. Projection and sections of prisms. Pyramids and cones with axis inclined and also with alteration of ground line.

(*d*) Intersections, Interpenetration of solids, development of plane and curved surfaces and determination of shadows.

(*e*) *Elements of Machine Drawing.*—Standard sections of rolled steel joints, rivets and simple riveted joints, screws, bolts and nuts and locking devices and drawing same from memory.

(*f*) *Geometrical Drawing.*—Technique and Principles of Graphical representation, including practice in precise pencilling, finished inking of instrumental construction, irregular curves and simple lettering and tracing.

(*g*) *Descriptive Geometry.*—The solution of geometrical problems as a means of developing the imagination and the power of visualisation.

FREEHAND AND MODEL DRAWING.

Elementary instruction in careful observation and accurate sketching in pencil from sketches and drawings and also from simple models and architectural details.

Accuracy in proportion, simplicity of presentation and unity of the whole are emphasized.

Out-door sketching from architectural subjects and building details.

PERSPECTIVE DRAWING.

The general theory of conical projection and its application to perspective, the method of revolved plan, direct division curves and apparent distortion. Relations between lines and points in the vanishing point diagram, the cubic system, methods of perspective. Plan and shadows.

ISOMETRIC DRAWING.

Isometric views and sketches of simple building parts. Masonry and timber details. Bond in Brickwork, footings in foundations. Carpentry joints—halving, lapping and notching and scarfing.

SURVEYING (Theory and Practice).

THEORY.

Introduction to Surveying.—Fundamental principles. Difficultics met with in Surveying.

Chain Surveying.—Units of measurements. Measuring instruments, cross staff, optical square prism, square, line ranger, etc., their use and adjustments. Arrangement of survey lines. Running of survey lines and conducting a project survey. Field operations, notes and records. Errors and how to avoid or minimise them. Special problems. Scales. Plotting and finishing of plans from field records.

Compass Surveying.—The main feature of the survey. The magnetic needle and its properties. Construction of Surveyors' and Prismatic compasses. Testing and adjusting the instruments. Use of the compass in conducting surveys. Traversing. Advantages and limitation of the compass. Booking of the field work. Plotting of a survey plan. Problems.

Plane Table Surveying.—The place of the Plane Table in Engineering surveys. Principles involved. The instrument and its adjunct field work. The several methods of conducting the survey. Standard problems. Errors in field work, remedies and precautionary measures adopted. Accuracy to be attained in topographic surveys.

PRACTICE.

Detailed study of the construction and use of the above instruments in the field. Each student will be given practical training in the field regarding the handling of all the instruments and conducting the above surveys. Each student is expecfed to prepare and submit Field Notes and Records and Plans of the practical work done by him during the course.

WORKSHOP (Practice).

(Any two out of the following shops)—

(i) *Fitter's Shop.*—Exercise in chipping, filing to straight edge and surface plate, scraping, groove cutting and key fitting, screwing and tapping. Use of scribing block, surface gauge and squares in marking outwork.

(ii) *Carpentry Shop.*—Sawing, Chipping and Planing, Joints, mortice, tennon and dove-tail joints.

(iii) *Smithy.*—Use of sledge hammer. Hand hammer, Cold and hot chisels. Top and bottom swages. Punches. Welding rods and rings. Preparing bolts.

(iv) *Foundry.*—Levelling. Moulding simple objects with or without patterns. Moulding by turning over method. Core making. Practice in Machine moulding and casting.